Technical Guidelines

for

Connection to District Cooling System

February 2013 Edition

EMSD

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1 Interpretation

"*consumer*", in relation to a building, means a person who is approved under the Ordinance as a consumer of district cooling services supplied to the building;

"*contract cooling capacity*" means the maximum designed cooling capacity required for providing district cooling services to the building as determined by the consumer of the building and agreed by EMSD on the approval of the application for connecting the building to the services;

"*consumer installation*" means the installation of chilled water system of the central air-conditioning system through the secondary side of each heat exchanger outside the substation and with the demarcation interfacing flange pipes inside the substation as installed by the consumer;

"*district cooling services (DCServ)*" means the supply of chilled water for air-conditioning purposes by a district cooling system vested in the Government, and other related services;

"*DCServ equipment*" means equipment such as chillers, pumps, heat exchangers, valves, fittings, metering and monitoring and control devices for the provision of district cooling services;

"*district cooling system (DCS)*" means a system in which chilled water is supplied from one or more central chiller plants to user buildings through a network of pipes for air-conditioning in, or provision of other related services to, the building;

"*EMSD*" means Electrical and Mechanical Services Department, the Government of the Hong Kong Special Administrative Region;

"*nominal flow rate*" in respect of any heat exchanger means the flow rate of chilled water at the secondary side of the heat exchanger corresponding to the contract cooling capacity at a supply temperature of $6^{o}C$ and return temperature of $14^{o}C$;

"*normal operating conditions*" at any time means all of the following conditions: (i) the consumer's cooling demand for DCServ is within the contract cooling capacity; and (ii) the chilled water flow rate at the secondary side of heat exchanger is greater than 10%, but not more than 100%, of the nominal flow rate of the heat exchanger;

"*operator*" means a person who has entered into a contract or management agreement with the Government for the management, operation and maintenance of a DCS;

"*substation*" means the site within the consumer's site boundary in which the heat exchangers, the chilled water pipes, meter and other associated equipment required by DCServ shall be housed.

2 Introduction

2.1 Scope

This “Technical Guidelines for Connection to District Cooling System” (hereinafter termed as “Guidelines") is to address the general principles to be applied to the design and installation works required for connection to DCS, including the provisions of substation located at ground floor or basement level of the building concerned.

2.2 Purpose

The objectives of this Guidelines are to ensure that all the design and installation requirements for connection to DCS and the substations provided by the consumers are designed to the same standard, and fully comply with the relevant requirements of government departments, utilities, telephone companies, and other authorities as required, and those requirements of the operator.

Other than the statutory requirements, this Guidelines is to be read in conjunction with other relevant ordinances, regulations and codes of practice published by HKSAR Government. In case, there are discrepancies between the requirements stipulated herein and the other ordinances, regulations and codes of practice, the more stringent requirement should prevail.

3 Application for DCS Connection

3.1 Application Procedure

Any party who wishes to apply for the DCServ shall complete and sign an Initial Application Form at preliminary design stage and an Application Form at later detailed design stage. The forms can be downloaded at EMSD website (www.emsd.gov.hk). The maximum designed cooling capacity will form the contract cooling capacity once the application was accepted by EMSD.

Upon receipt of an application, EMSD or the operator

- May require additional information to be submitted by the applicant
- Shall advise the applicant of the connection scheme and technical requirements

The procedure shall include but not limited to the following:

- Information submission by the consumer, including completed application form, cooling demand calculation methods, secondary side water-side drawings & etc.
- EMSD or the operator will review the information submitted by the consumer
- Discussion on the design of substation and interfaces. On the substation detailed layout drawings, EMSD or the operator will suggest possible location of DCServ lead-in chilled water pipe and control cable to the consumer
- Confirmation of the cooling demand, substation location, trench location, works programme & service commencement date
- For any such non-standard connections on top of the standard provision, the consumer shall provide relevant information to EMSD or the operator for consideration and approval. The supply, installation and maintenance of such additional facilities and equipment shall be carried out by the consumer at his own cost
- Preparation of construction drawings by the consumer. The substation layout plans prepared by the consumer should be submitted to EMSD or the operator for agreement. The submitted drawings should be in both hardcopy and softcopy format. The softcopy should be in ".dwg" format and compatible with either one of the latest three AutoCAD® versions
- The consumer must submit the detailed layout drawing incorporating the finalized pipe trench and exact position of interface services together with the works programme for agreement by EMSD or the operator prior to installation
- Construction of the substation, trench excavation, backfilling by the consumer
- After join inspection with satisfaction, the substation will be taken over by EMSD for the installation of heat exchangers and related facilities in the substation. Before testing and commissioning of the heat exchangers and related facilities, consumer shall submit pressure test report and water treatment details and report to EMSD
- Issuance of handover completion report by the consumer to EMSD or the operator after testing and commissioning
- EMSD or the operator will commence the operation and maintenance of DCServ equipment in the substation

3.2 Handover date for EMSD's installation

EMSD or the operator shall agree with the consumer on a handover date of trench and substation such that EMSD can install the equipment on time. The handover date is normally five (5) months before the target chilled water supply date. After taking possession of the trench and substation, EMSD will install the heat exchangers including chilled water pipes and accessories within site boundary and substation. The consumer shall complete all the required

testing and commissioning works of consumer installation and EMSD will coordinate with the consumer for testing and commissioning of heat exchangers and this is normally one month before the target chilled water supply date. Once the chilled water supply of DCServ commences, the consumer is required to pay for the DCServ charge onwards.

4 District Cooling Services Specification

4.1 Supply Temperature

4.1.1 EMSD or the operator shall normally operate the DCS to supply chilled water at primary side of heat exchanger, measured at 30-minute interval, at Design Primary Supply Temperature of 5°C ± 1°C under normal operating conditions and the return temperature on consumer side shall normally be maintained at 14°C.

4.2 Supply Quality

4.2.1 EMSD or the operator shall exercise reasonable care and skill to provide the consumer with an uninterrupted supply within the Design Primary Supply Temperature on a 24 hourly basis under normal operating conditions.

4.2.2 EMSD or the operator shall use its best efforts to prevent any interruption in the provision of DCServ and to minimize the duration of any such interruption. EMSD or the operator shall notify the consumer as soon as practicable by email and short messaging service (sms) or telephone if there is unexpected significant change in the operating status of DCServ or if any interruption is expected to occur.

4.2.3 DCServ may be interrupted or may deviate from the Design Primary Supply Temperature as specified in clause 4.1.1, but not limited to, the following circumstances:-

a) When EMSD or the operator takes necessary actions for safety reasons;

b) When EMSD or the operator makes improvements or carries out maintenance, repairs or works;

c) When matters outside the control of EMSD or the operator causes it do so; or

d) Faults in the consumer installation.

4.2.4 The consumer may at its own cost make suitable back-up plant (including the chiller plant and heat rejection system) for the air-conditioning of the building if the operations of the building cannot tolerate any failure, reduction, interruption, variation or inconsistency in the supply.

4.3 Supply Capacity

4.3.1 EMSD or the operator shall use its best efforts to provide the consumer the required cooling capacity under normal operating conditions at all times provided that the consumer shall maintain the chilled water return temperature at 14°C.

5 General DCS Connection Design Guidelines

General design criteria are established in this Guidelines so that the consumer can provide the basic requirements for the substation for the interface with DCServ during building design.

5.1 General

5.1.1 The consumer shall at its own cost provide and construct the substation in accordance with the plans and specifications agreed by EMSD. Such plans and specifications shall not be altered without the approval in writing by EMSD or the operator. The consumer shall ensure that the substation shall only be used for plant and equipment linked to the provision of DCServ within the consumer's site boundary.

5.1.2 The consumer shall at its own cost maintain the trench and cover for pipework installation and substation within the consumer's site boundary inclusive of building structure, infrastructure, building services and general cleanliness within the substation.

5.2 Connection between the DCS Network and Substation

5.2.1 Valve Chamber

5.2.1.1 The location of consumer's isolation valve chamber is to be assigned by EMSD, subject to negotiations with other relevant government departments.

5.2.1.2 The consumer's isolation valve chamber that serves as a main switch to separate the chilled water network and individual consumer, shall be built, operated and maintained by EMSD. It is normally located outside the periphery of consumer's site boundary and shall be easily accessible for daily operation and emergency isolation of the pipework.

5.2.2 Pipes & trenches from valve chamber to substation

5.2.2.1 Only DCServ pipes & valves are to be built, operated and maintained by EMSD.

5.2.2.2 For the avoidance of doubt, other facilities and infrastructure for connection from valve chamber to substation, such as, but not limited to pipe trenches, thrust blocks (if any), backfilling, protection and covers are built, operated and maintained by the consumer. The routing and size are to be mutually agreed by the consumer and EMSD. However, a minimum clearance of 1.5m from DCServ pipeline shall be reserved from the ground level and other utilities.

5.2.2.3 The cross-sectional areas of pipe trenches should not be reduced by ground beams or other civil/building structures. The invert level of pipe trenches at the boundary of the substation should be coordinated with EMSD. If ground beams are present at the boundary of the substation, the clearance under the beams should be considered. Trench should be built with bedding with at least 100mm of compacted sand and the depth required should take into account of the gradient requirement of the pipes to be laid. Pipe trench should be allowed to lay three nos. of chilled water pipes at same level and 2 nos. of cable duct at each side of trench (total 4 nos.). Bends should always be avoided. Unless agreed by EMSD, bends should not exceed 4 nos. for each pipe run to limit the friction loss. Vertical bend (e.g. "U" & "Λ" bend) shall be avoided to prevent from dirt and air accumulated. If these bends will be used for pipes, drain valve and air vent with valve pit with adequate maintenance space shall be provided.

5.2.2.4 Bell hole with the minimum size of 2000mm width and 800mm depth shall be provided at the welding joint of DCServ pipe. The bell hole shall be backfilled with sand by the consumer.

5.2.2.5 Draw pit(s) for minimum size of 1100mm(W)x1100mm(L)x1500mm(H) for 4 nos. of uPVC cable duct for control cables shall be provided by the consumer.

5.2.2.6 Pipes will be direct buried and shall be backfilled with sand by the consumer. All backfills shall be properly deposited and compacted to standards not less than the

following:

(a) The excavation shall be backfilled with suitable materials (sand for bedding up to 300mm above DCS pipes and general fill from 300mm above DCS pipes to formation) in compacted layers. The backfill materials shall not contain any broken concrete, bricks, clay, bituminous material, materials susceptible to spontaneous combustion, perishable materials or debris. Sharp stones or objects shall not be used as backfilling material to prevent damaging the cladding of DCS pipes;

(b) Sand shall be used as the bedding material of DCS pipes with a minimum thickness of 100mm;

(c) The backfilling shall be carried out in accordance with the requirements and procedures specified in the latest edition of General Specification for Civil Engineering Works or General Specification for Building, whichever is appropriate.

5.2.2.7 Trench width and depth for different cooling capacity should refer to Table D1 in Appendix D.

5.2.2.8 General arrangement on construction of substation should refer to Fig. C1 in Appendix C.

5.3 Substation Location

5.3.1 In order to reduce the pipe length, minimize pipe routing space and risk of water leakage, the substation shall be located as close as possible to the consumer's isolation valve chamber located outside the periphery of consumer's site boundary feeding chilled water to the substation. The substation shall preferably be located as the periphery of the building to ensure ease of installation and operation and maintenance. In normal case, only one substation should be provided for the consumer.

5.3.2 For ease of moving heavy equipment, the substation shall be located in ground floor (road level) or at basement 1 (one level below road level). In any case, the top level of the substation (including the pipe top level) is limited at or below +10mPD. Protection shall be provided for the DCServ pipe if the pipe will be installed above ground and shall be approved by EMSD before installation.

5.3.3 The exact location shall be agreed with the consumer and EMSD.

5.4 Typical Substation

In general, all equipment installed in the primary side and secondary side of heat exchanger including heat exchanger itself within substation are to be supplied, installed, operated and maintained by EMSD. Details shall refer to Fig. C1 and Fig. C2 in Appendix C.

5.4.1 Layout

5.4.1.1 Typical substation layout and dimensions for two heat exchangers and three heat exchangers are indicated in Fig. C3 and Fig. C4 in Appendix C and Table. D1 in Appendix D. The layout and table show the minimum dimensions which is subject to the change in according to EMSD’s comments and suggestions.

5.4.2 Substation Dimension

5.4.2.1 The substation should be planned in accordance with the maximum designed cooling capacity. The cooling load calculation method, secondary side water-side schematic and assumptions of the building shall be submitted to EMSD in the application form as described in Section 3.1 for review and approval. This can ensure that adequate cooling capacity is reserved for the consumer.

5.4.2.2 The dimensions of the substation are dependent on the maximum designed cooling capacity. The indicative dimensions and provisions are listed in Table D1 in Appendix D. The table shows the required minimum dimensions which is subject to change due to site conditions and/or comment from EMSD or the operator. The layout and provisions shall be discussed and agreed with EMSD or the operator before installation.

5.4.3 Heat Exchanger

5.4.3.1 Adequate numbers of heat exchangers will be installed inside the substation depending on the maximum designed cooling capacity by the consumer (see Table 5.1 below). The provision of heat exchanger in the table below is for design reference, the exact number of heat exchanger shall be discussed and agreed with EMSD.

Cooling Capacity (kW)	Heat Exchangers (no. x kW)
100	2 x 60
200	2 x 120
300	2 x 180
400	2 x 240
500	2 x 300
1000	2 x 600
2500	2 x 1500
5000	2 x 3000
7500	2 x 4500
10000	3 x 4000
12500	3 x 5000
15000	3 x 6000
20000	3 x 8000
24000	4 x 7200

Table – 5.1 Reference Schedule of Number of Heat Exchangers vs Cooling Capacity of the Building

5.4.3.2 The number of heat exchangers and necessary components to be provided by EMSD in the substation will be determined by EMSD as the standard provision.

5.4.3.3 The following general criteria of heat exchanger are used for the design of consumer installation by the consumer:

a) The supply water temperature on the primary chilled water side is 5 ± 1°C

b) Secondary return chilled water temperature should be at 14°C

c) Close temperature approach, within 1°C, is adopted for the heat exchanger

d) Maximum working pressure of 16 bar

e) Pressure drop across heat exchanger at rated flowrate : 50kPa

f) Minimum flow rate at secondary side of each of heat exchanger is 20% of its nominal flow rate

g) The heat transfer plates is single wall type and complied with BS 7766 and manufactured from stainless steel AISI 316 with a minimum thickness of 0.5mm.

5.4.3.4 If the consumer estimates that the cooling demand for DCServ is often very low comparing to the contract cooling capacity, additional smaller heat exchanger(s) may be requested to cater the low load conditions. The consumer shall provide relevant information for EMSD's consideration and approval. The consumer shall provide larger size of substation for installation of additional heat exchanger(s).

5.4.4 Interfacing for Metering

5.4.4.1 EMSD will only provide one set of metering device in the substation as the standard provision. These metering devices are to measure and record the chilled water capacity and consumption information at primary side. All these metering devices should be supplied, installed, operated and maintained by EMSD. Adequate pipe run shall be reserved for these metering devices to allow accurate measurement.

5.5 Building Requirements for Substation

All these building provisions should be provided and maintained by the consumer. The detail requirements of the building provision are described in the following section.

5.5.1 General Requirements

5.5.1.1 All substations should comply with all applicable statutory requirements.

5.5.1.2 For the substation on ground level, they should be directly accessible from open air (non-covered area) at all times. The permanent access to the substation should be of adequate height, width and of sufficient strength to withstand the combined weight of the equipment and the conveying vehicle during installation and subsequent operation and maintenance.

5.5.1.3 For DCServ substation location exposing to the risk of flooding such as near an inclined road, slope and sea front, anti-flooding provisions should be built to prevent flooding of the substation. Kerb at doors should be constructed after delivery of heat exchangers by EMSD. Ground level substation should be at least 150mm higher than the outside (pavement) level to reduce the risk of flooding.

5.5.1.4 Sufficient space for delivery access should be allowed for equipment delivery for installation, maintenance and replacement with all leveled ground.

5.5.1.5 Minimum clear headroom of different cooling capacity (excluding any lifting hook) should be referred to Table D1 in Appendix D inside the substation to install the heat exchanger and relevant equipment.

5.5.1.6 Permanent hoisting facilities should be provided for each heat exchanger within the substation for delivery, installation, maintenance and replacement.

5.5.1.7 For special circumstances, the consumer should obtain EMSD prior agreement on building requirement.

5.5.1.8 The substation shall be solely for the DCServ equipment and building services serving only the substation. Other utilities, equipment, control panel and system not intended for DCServ shall not be installed within the substation.

5.5.2 Additional Requirements for Substation Location other than Ground level

5.5.2.1 The substation should be directly accessible from the open air at ground level by a shared staircase.

5.5.2.2 Emergency exit route diagram should be provided in the substation.

5.5.2.3 Enough access leading from street level to the substation should be provided for equipment delivery.

5.5.2.4 Curb to be provided if necessary, provision (i.e. height of curb) subject to specific site condition / location.

5.5.3 Equipment Dimensions, Weights and Operational Space

5.5.3.1 The clearances and operating areas required around the equipment have been considered with due consideration for future operation, maintenance and upgrade.

5.5.3.2 In general, the minimum clearance required around the heat exchangers are:-

a) 1000mm on the back side

b) 1500mm between side wall and heat exchanger

c) 1500mm between each heat exchanger

The above dimensions given are measured from plinth to plinth and subject to final approval by EMSD.

5.5.4 Foundation/ Plinth

5.5.4.1 The heat exchanger foundation/ plinth to be provided by the consumer should be capable of supporting equipment load. The dimensions of the equipment plinth should be considered as well as plinth level with finished floor level. The indicative dimensions are listed in Table D1 in Appendix D.

5.5.4.2 The foundation should be capable of supporting a maximum static plus dynamic load per equipment. The minimum cover between the finished floor level with proper design for the reinforcement bar of the plinth should be considered. The floor surface should be flat and within a proper tolerance. The structural floor loading should be designed of at least 20kPa.

5.5.5 Door requirement

5.5.5.1 Doors with secured key lock should be provided to EMSD or the operator for the substation and should be available during the handover of the substation to EMSD or the operator. Only EMSD or the operator has the key to the substation once the substation is handed over to EMSD or the operator for installation. The door width and height should be enough for equipment delivery. The door fire resisting period (FRP) should be the same as the fire compartment as required in the Code of Practice for Fire Resisting Construction issued by Building Department.

5.5.6 Internal Finishing

5.5.6.1 Substation shall have finished painted walls and oil resistant non-slip finished floors.

5.6 Access to Substation

5.6.1 Chilled water lead-in pipes

5.6.1.1 The substation shall require an aperture sufficient for the chilled water lead-in pipes and control ducts. The location, size and level of the required aperture will depend on the tap-off location, entry level and chilled water lead-in pipe diameter. The details of these requirements shall be provided by EMSD or the operator.

5.6.1.2 EMSD shall provide the pipe with puddle flange for the consumer to install when the chilled water lead-in pipes penetrate through consumer's building. The water stop for uPVC control cable duct shall be provided and installed by the consumer. To avoid doubt, consumer shall be responsible for the water proofing and pipe seal and shall be maintained by the consumer.

5.6.1.3 Builder's works drawings for the slab opening(s), aperture(s) and other associated details for the DCServ pipe penetrations shall be agreed by EMSD or the operator prior to the works commencement.

5.6.2 Delivery

5.6.2.1 The minimum loading of the route for delivery of the equipment should be sufficient to support the equipment weight and the delivery equipment.

5.6.2.2 EMSD shall deliver the equipment to the substation. The consumer shall provide all necessary support for the delivery of the equipment during installation and operation and also the subsequent replacement due to maintenance issue.

5.6.2.3 Hoisting equipment shall be provided for the installation work and future operation and maintenance. The size of the hoisting equipment shall be able to lift all the heat exchangers and valves inside substation. Details shall be agreed during coordination on site.

5.7 Building Services Requirements for Substation

The building services provision inside the substation should include mechanical ventilation, fire services provision, plumbing & drainage, electrical services and telecommunication. All these building services provision should be provided and maintained by the consumer, including all the subsequent utilities costs such as electricity cost, water cost, telecom cost, etc. The detail requirements of the building services provision are described in the following section.

5.7.1 Mechanical Ventilation System

5.7.1.1 The substation should be adequately ventilated with a fixed mechanical ventilation system.

5.7.1.2 The height of the ventilation outlet to free air should be minimum 2.5m above street level. The air outlet stream should be directed away from personnel on the footpath nearby.

5.7.1.3 Effective inlet louvre area should be considered and determined. Filter shall be provided and maintained by the consumer at the supply inlet.

5.7.1.4 The air duct should be painted in white colour with exhaust air direction labels in black painted on the air duct.

5.7.1.5 The mechanical ventilation system should be provided by the consumer to maintain a proper indoor plantroom condition. Both ducted and non-ducted ventilation systems are acceptable.

5.7.1.6 The mechanical ventilation fan(s) are needed to control by a temperature sensing device to avoid unnecessary operation.

5.7.1.7 The supply and exhaust fans, if installed, should be switched on simultaneously.

5.7.1.8 The noise level generated by the ventilation system should comply with requirements of the Noise Control Ordinance.

5.7.2 Plumbing and Drainage Services

5.7.2.1 The plumbing and drainage services should comply with requirements of Building Ordinance.

5.7.2.2 Minimum size for floor drain should be 100 mm for proper floor wash down and drainage as standard permanent provision. Discharge point should be available prior to testing and commissioning of the DCServ equipment.

5.7.2.3 One cleansing trough with faucet of 32mm water inlet point should be provided as standard permanent provision and should be available prior to testing and commissioning of the DCServ equipment.

5.7.2.4 The substation floor slope shall also be designed to follow the Best Engineering Practice, in order to ensure proper water drainage.

5.7.2.5 A pit with sump pump shall be provided inside the substation. An automatic and manual switch for operation of sump pump shall be provided.

5.7.2.6 A high water level sensor with control panel inside the substation shall be provided to raise a flooding alarm with flashing light at the door of substation. The flooding signal shall be transmitted to the main control panel of building. The consumer shall provide a repeated signal to EMSD’s DDC panel in the substation.

5.7.3 Fire Service

5.7.3.1 The fire service provision should comply with the statutory requirements of Fire Services Department (FSD). In general, heat detectors and fire extinguishers should be provided in the substation. The exact fire service provision should be subject to the approval by FSD.

5.7.4 Lighting System

5.7.4.1 Illumination inside the substation should be average 200 lux measured on the floor level of the substation.

5.7.4.2 The adjacent lighting fittings should be fed from different circuits of the distribution board such that illumination inside the substation will not be totally lost when one lighting circuit is tripped.

5.7.4.3 Twin fluorescent batten fittings for 1.2m energy efficient T5 fluorescent tube or more energy efficient lighting fittings should be used. The lighting fitting shall have IP rating of IP54.

5.7.4.4 Battery operated fixed lighting and exit sign should be provided to enable a safe exit to be made from the substation in the event of loss of power supply. The battery shall be maintained for at least 2 hours operation.

5.7.4.5 The provision of emergency lighting of 2 lux measured on the floor should be provided in accordance of the Code of Practice for Minimum Fire Services Installations and Equipment issued by FSD.

5.7.5 Power Supply System

5.7.5.1 The power supply to the substation should be provided by the consumer. The distribution board should be located near the main access door and should house a 32A SPN main switch together with an adequate number of final circuits protected by miniature circuit breaker (MCB) for lighting installation, small power, ventilation and metering/control equipment. The distribution board shall have IP rating of IP 54 and be supplied with preferably back-up power supply. Sufficient number of 13A single phase socket outlets should be provided for general maintenance.

5.7.5.2 The power supply for EMSD's instrumentation & control and other accessories shall be provided in each substation near EMSD's DDC panel by the consumer.

5.7.6 Telecom Facilities

5.7.6.1 One telephone/data outlet completed with 25mm diameter conduit should be provided and connected to the TBE Room of the building. Mobile signal shall be covered inside the substation.

5.7.7 Earthing

5.7.7.1 Earthing terminal connecting points to the main earthing terminal of the building should be provided inside the substation.

5.7.7.2 Earthing should be provided to all electrical equipment including, but not limited to, lighting fixtures per the Code of Practice for Electricity (Wiring) Regulations issued by EMSD.

5.8 Provision of Building Services Equipment and Services during Installation

The following temporary facilities/services shall be provided by the consumer during installation and testing and commissioning (T&C) periods to facilitate the installation and T&C of heat exchangers and other DCServ equipment if the permanent facilities/ services could not be available at handover of substation. Further coordination with EMSD shall be required before works commencement.

a) Power supply – temporary power of one 60A TPN and one 20A SPN shall be provided during installation and T&C periods. Permanent power of 32A SPN shall be provided 3 weeks before the chilled water supply date;

b) Plumbing and drainage – temporary dewatering pumps, pipes and associated controls shall be provided. Permanent plumbing and drainage system shall be provided 10 weeks before the chilled water supply date;

c) Fire services provision;

d) Security for the substation;

e) Storage area for DCServ pipe, equipment and tools; and

f) Provision of refuse collection point.

6 Compatibility of Design of the Primary and Secondary Sides

6.1 Equipment to be Installed in Secondary Side by EMSD Inside Substation

6.1.1 Temperature and pressure sensors and gauges of the supply and return lines on the secondary side to be supplied, installed and maintained by EMSD.

6.1.2 Strainers, pressure relief valves, dismantling joints (or flexible bellows), drain pipes and air vent inside the substation to be supplied, installed and maintained by EMSD for operational, safety and maintenance purposes.

6.1.3 Temporary flushing by-pass connection to be installed on the secondary side pipes by EMSD for flushing the secondary circuit inside the substation without passing water through heat exchangers.

6.1.4 An ON/OFF motorized valve will be installed on the secondary side return pipe of each heat exchanger by EMSD to control the on/off operation of heat exchanger. The number of heat exchanger to be operated will depend on the instantaneous cooling demand required and flow rate of secondary side of heat exchanger.

6.2 Equipment to be Installed in Secondary Side by the Consumer

6.2.1 Industrial grade automatic air vents at all the high points of the consumer's internal chilled water system.

6.2.2 Chilled water treatment system including manual feed chemicals, dosing pot with necessary rust inhibitors and biocides with sufficient quantity necessary for testing, commissioning and operation. A specialized water treatment company shall handle the water treatment system.

6.3 Recommendations to Ensure Compatibility

To ensure the district cooling system is compatible, some recommendations are stated below and detailed in Appendix A and B.

6.3.1 All terminal equipment such as air handling units, fan coil units etc. shall be designed to

a) Supply Temperature = 6°C ± 1°C

b) Return Temperature = 14°C

6.3.2 Variable speed secondary chilled water pumps are recommended for the internal distribution of the consumer's chilled water system or other mean which the consumer considers it can efficiently control secondary chilled water. Operation of variable speed secondary chilled water pumps shall be combined with internal distribution of the consumer side chilled water system based on 2 way valves with modulating actuator for each AHU and FCU. Varying the consumer's side chilled water flow is required to maintain the differential temperature across the substation heat exchanger and achieve the desired delta T.

6.3.3 Modulating valves shall be installed at the bypass pipe between the chilled water supply and return lines of the consumer's secondary circuit. If the secondary side (consumer side) chilled water return temperature is below 14 °C, the modulating valve shall operate and enable re-circulating of chilled water to enable the chilled water return temperature to the heat exchanger as high as practical.

6.4 Consequences

If the consumer's secondary chilled water return temperature is lower than 14°C, the delta temperature of DCS supply and return will be in a lower range. Thus, this will decrease the efficiency of pump and EMSD will incur additional pumping costs and significant loss of chiller capacity at the DCS plants. Consequently, the reliability and service level of supply cannot be guaranteed as a result of the consumer in the system inability to comply with return temperature requirement.

7 Testing and Commissioning and Handover of Substation

7.1 Hydrostatic Pressure Testing

The consumer will be responsible for filling their internal chilled water system at initial start of the commissioning and any make-up water requirement during the operation of the plant.

Pressure test of the consumer internal chilled water pipe work hydraulically at a minimum of 1.5 x system working pressure for the internal distribution piping for a period of not less than 4 hours without any drop in pressure to ensure that the pipes are free from leak. The results of hydrostatic test report shall be submitted to EMSD or the operator for approval.

7.2 Flushing and Cleaning

The consumer shall perform a complete and thorough flushing of the internal chilled water piping network using cleaning chemicals and potable water as recommended by the water treatment specialist of the consumer to ensure that at the time of supply of DCServ, the consumer's piping system is full of clean water and is clear from unwanted debris. To achieve that, the consumer has to install a temporary bypass at consumer installation for the purpose of circulating water through the internal network. Consumer side cleaning method, flushing and chemical treatment details shall be submitted to EMSD or the operator for review and obtain approval, prior to commencement of each activity.

EMSD will install a temporary bypass at each heat exchanger for performing a complete and thorough flushing of the chilled water piping of secondary side of heat exchangers inside the substation. The heat exchangers and interfacing valves with consumer installation will be isolated during flushing.

The consumer shall submit flushing and cleaning method and water treatment report to EMSD for approval before supply of DCServ. The purpose of this approval is to ensure that the flushing and cleaning has no adverse effect on the heat exchangers. However EMSD or the operator's review and agreement shall not relieve the consumer of the responsibility of ensuring industry standard procedures for flushing, cleaning and passivation of secondary side piping and associated works.

8 Interfaces during Operation and Maintenance

8.1 Access for O&M and Data Reading

8.1.1 Adequate space accessible without any obstruction for data taking, maintenance and replacement should be allowed in the substation to accommodate the equipment which is to be supplied, installed, operated and maintained by EMSD or the operator.

8.1.2 The substation should be locked to keep out unauthorized personnel and only EMSD or the operator has the key to the substation.

8.1.3 The personnel access shall be freely accessible by EMSD or the operator 24 hours a day to conduct operation and maintenance and inspection so as to ensure continuous and reliable supply of chilled water.

8.1.4 The consumer shall make request with EMSD or the operator for access the substation for routine maintenance and inspection of their installations or equipment.

8.1.5 For the avoidance of doubt, should there be any civil and/or builder's work required for DCS within the site boundary, the consumer shall provide suitably sized access such as but not limited to repair access and subsequent make good at no cost to EMSD or the operator.

8.2 Water Treatment

8.2.1 In a closed water loop with minimal make-up water requirements, chemical water treatment is normally used to neutralization of corrosive properties and control of scaling in heat exchangers. The consumer is responsible to provide adequate water treatment in the secondary circuit of the heat exchanger.

8.2.2 The consumer shall submit water treatment report for the secondary side to EMSD or the operator on a monthly basis.

8.3 Meter and Metering

8.3.1 EMSD will provide one set of metering device as mentioned in Section 5.4.4 in the substation as the standard provision.

8.3.2 The metering equipment shall be supplied, installed and maintained by EMSD.

8.3.3 EMSD or the operator will deliver the best efforts to maintain the meter to record the energy usage by the consumer in good order from time to time. However, if there is power interruption from consumer side and the meter fails to record the energy consumption during the period, EMSD or the operator have the right to make a reasonable estimation on energy usage during the period based on the historical data. The estimation amount will be noted in the consumer invoice for record.

8.3.4 In order to maintain the accurate energy metering, regular validation of meter accuracy will be performed by EMSD or the operator. During the validation period of about one hour, the metering function will be suspended. Therefore, EMSD or the operator will also make a reasonable estimation on energy usage during the period based on the historical data. The estimation amount will be noted in the consumer invoice for record.

8.3.5 If the meter shall for any reason become faulty or inaccurate beyond the accuracy permissible limits, EMSD or operator shall as soon as possible procure the service, repair, re-calibration or replacement of such meter as appropriate. If the consumer disputes the accuracy of the meter, the consumer may request EMSD to have the meter tested by an independent agency. EMSD or the operator may charge for this service if the meter is found to operate within the permissible limits.

Appendix A – Fundamentals of DCS

a) Principle

District cooling is a system in which chilled water is supplied from one or more central chiller plants to user buildings through a network of underground pipes for space air-conditioning in the buildings. The cooling and heat rejection is provided from the central chiller plant. A DCS contains three major elements: the cooling source, distribution system, and substations.

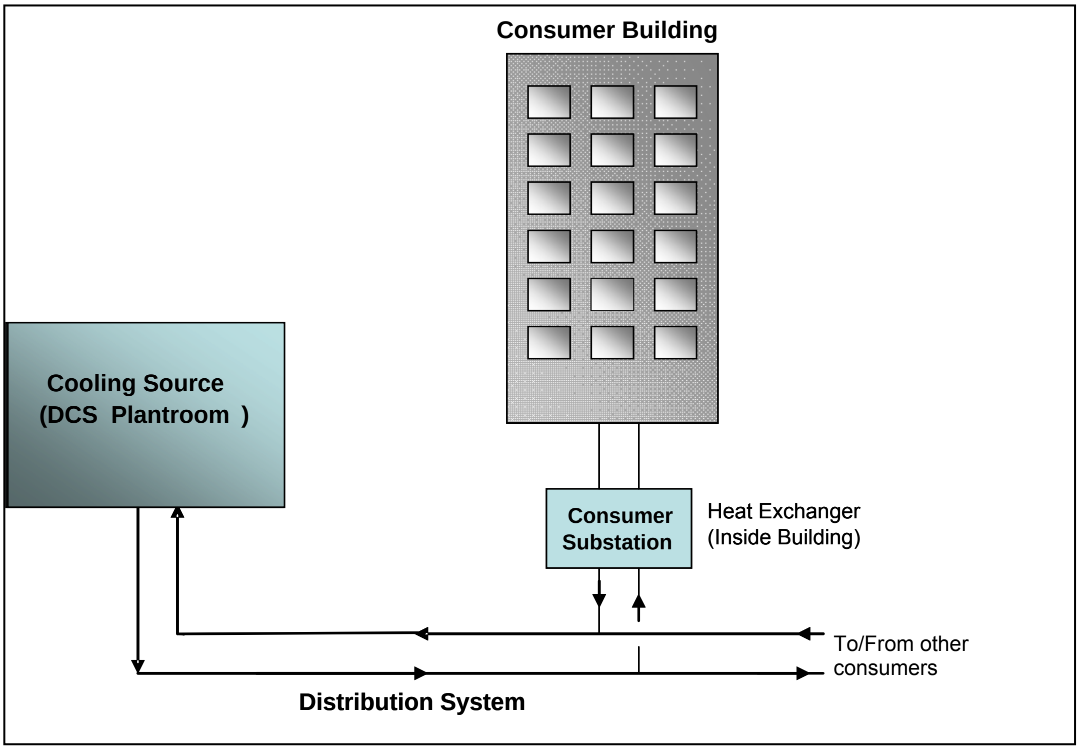


Fig. A1 – Elements of a District Cooling System

The cooling source is generally equipped with electrical compressor driven chillers which generate chilled water to cope with the cooling demand. Chilled water is distributed by variable speed pumps which creating a pressure differential between the supply and return pipes of the distribution system. The interface between the DCS and the building air-conditioning system is the substations.

b) Key components

(i) DCS Plants

Chilled water for KTD sites is generated from the Northern and Southern DCS Plants where equipped with electric driven seawater-cooled chillers to serve the north and south portion of the KTD respectively. These two DCS Plants comprise chillers, chilled water pumps, controls, power supply and supporting facilities.

Since the chilled water flow rate is high, variable speed pumping system will be adopted in order to optimize the energy consumption. Variable speed pumps will distribute chilled water to the DCServ distribution network and then to the substations according to the load profile.

(ii) Distribution Network

Chilled water is distributed from the cooling sources to the substations through supply pipes and is then returned after extracting heat from the building's air-conditioning load. Variable speed pumps housed in the Northern and Southern DCS Plants distribute the chilled water by creating a differential pressure (DP) between the supply and return lines. The pump head is selected to overcome the flow

resistance in the supply and return lines plus the differential pressure in the substation at the critical node of the system. Control valves, sized for a large flow operating range responsive to the variations in the demand for cooling in the building, governs the amount of water that flows through each substation at KTD.

(iii) DCServ Consumer Substation

The substation will be built within the lot boundary of the consumer building to convey cooling energy from DCS to the chilled water system of that building. The DCServ consumer substation is designed for indirect connection between the DCS distribution network and the building chilled water system through multiple (minimum two nos.) heat exchangers.

Indirect connection is chosen instead of direct one because,

- The head loss at the substation can be determined in a simple manner for calculating the required system pumping pressure.
- Cross contamination between the DCServ loop and the building loop is avoided. Primary chilled water system owned by EMSD is protected from interventions in the buildings.
- Clear demarcation of system boundary for system liability and maintenance responsibility.

Chilled water pipes from the DCS distribution network are connected to the plate type heat exchangers installed inside the substation. The heat exchanger together with the pipework inside the substation will be provided by EMSD.

The designed chilled water supply and return temperatures at the primary chilled water side at the substation for KTD DCServ under normal operating conditions are,

- Supply Temperature = 5°C ± 1°C
- Return Temperature = 13°C

The designed chilled water supply and return temperatures at the building chilled water side under normal operating conditions are,

- Supply Temperature = 6°C ± 1°C
- Return Temperature = 14°C
  (1°C temperature rise through heat exchanger as recommended by manufacturer)

Both EMSD or the operator and the consumer have the obligations to fulfill the design conditions to ensure energy efficiency and all consumers are supplied with quality chilled water according to the design.

Appendix B - Recommendations to Secondary Side System

1) Air Handling and Terminal Units

It is necessary to:

- Use variable flow chilled water system and two way equal percentage control valves for all air handling units and fan coil units and the control valve shall be capable of controlling flow through full range of expected turn-down and through full range of expected differential pressure across the valve;
- Fit all air handling units, fan coils units and main branches with double regulating balancing valves with self-sealing test point used for chilled water flow measurement as required during balancing and commissioning;
- Install strainers on all air handling unit supply chilled water pipe;
- Test, adjust and balance the hydraulic system to make sure that the chilled water requirement of each fan coil unit and air handling unit is met, preferably the testing and balancing shall be carried out by a specialized third party commissioning firm; and
- Operate the AHU/FCU chilled water valve with reference to the Return Air Temperature of the AHU/FCU. Since Return Air Temperature represents the actual heat load from the building, controlling the chilled water valve with reference to Return Air Temperature sensor instead of either Supply Air Temperature or Off-Coil Temperature will save energy and maintain the return water temperature comparatively on higher side.
- The chilled water modulating valve shall be closed when AHU fan's status is off. This shall be added in the PLC/DDC programme logic as an interlock to operate the PID loop of modulating valve. The chilled water valve shall modulate based on the set point when the status of machine is "ON" and follow the PID logic.

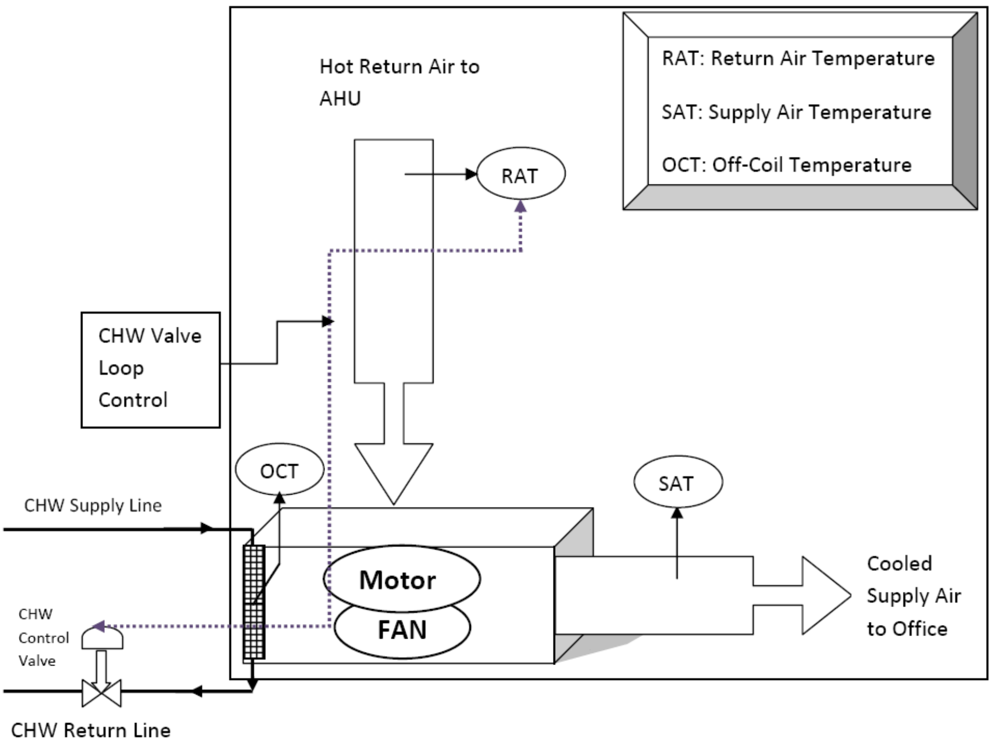


Fig. B1 – Air Handling and Terminal Units

- It is recommended to install a modulating control valve between the chilled water supply and return lines of the secondary circuit. Modulating control valve shall be interfaced with the chilled water return temperature on the secondary side (consumer's side) to maintain the return temperature at 14 °C.
- Only two way control valves shall be selected and installed to ensure that the variable chilled water flow technical design principle works properly at the consumer side throughout the year, especially in achieving the expected chilled water return temperature.
- If the secondary side (consumer's side) chilled water return temperature is below 14 °C, the modulating bypass valve shall operate and it shall be capable of re-circulating up to 2/3 of the full secondary side design flow to enable the chilled water return temperature to EMSD heat exchanger to be maintained as high as practical.

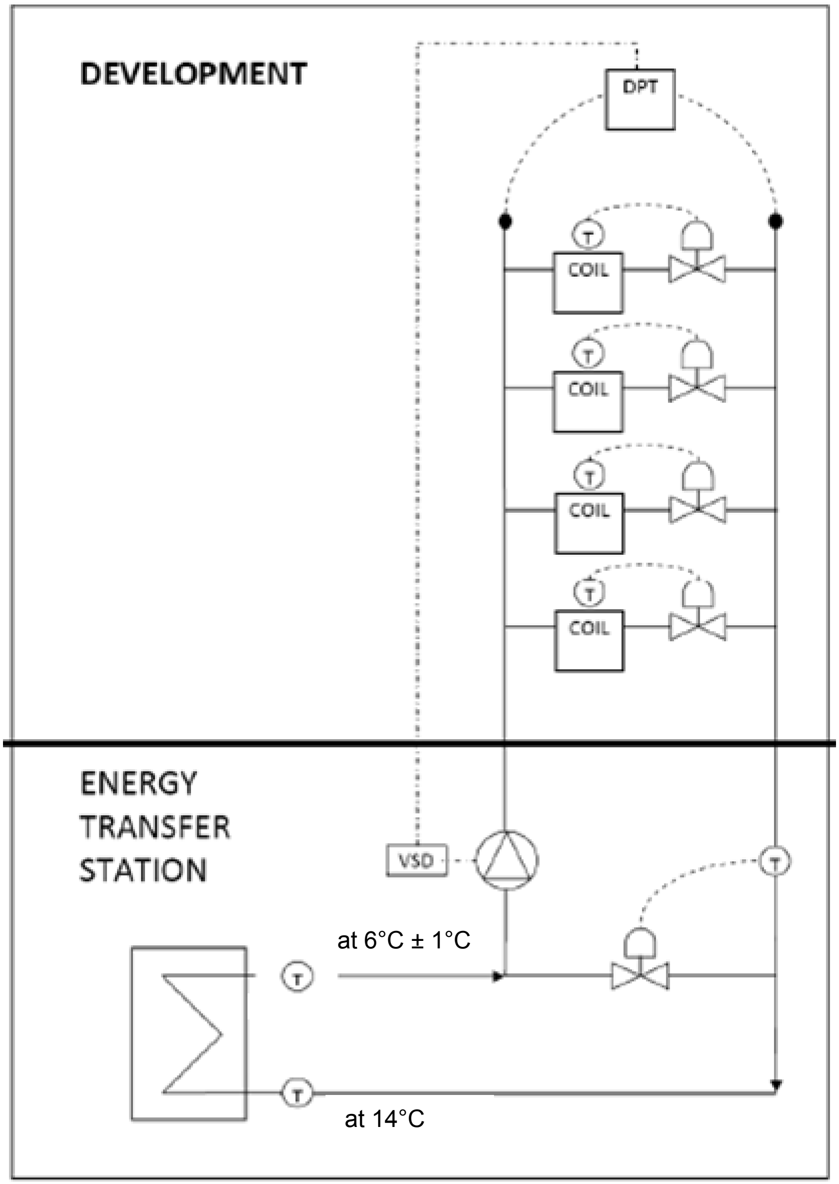


Fig. B2 – Mixing Valve at Secondary Side

3) Secondary Chilled Water Pump Control

- Consumer side chilled water pumps shall be controlled based on the Differential Pressure Transmitters (DPT) installed at the consumer's side of the chilled water system (these works on the consumer's side of heat exchangers are the responsibility of the consumer).
- It is recommended to use an industrial grade DPT located across the hydraulically far end of the chilled water pipes for each building if the secondary circuit serving more than one building, secondary pump frequency/speed shall be controlled based on the input from DPT(s) sensor.

4) Operation of Heat Exchanger

- The modulating valve on primary side of heat exchanger will be commanded to fully close if the modulating valve on secondary side of consumer installation is in fully closed position.
- To have better control and enhancing energy efficiency of DCS chiller plant, an ON/OFF motorized valve will be installed on the secondary side return pipe of each heat exchanger by EMSD to control the on/off operation of heat exchanger. The number of heat exchanger to be operated will depend on the instantaneous cooling demand required and flow rate of secondary side of heat exchanger.

Appendix C

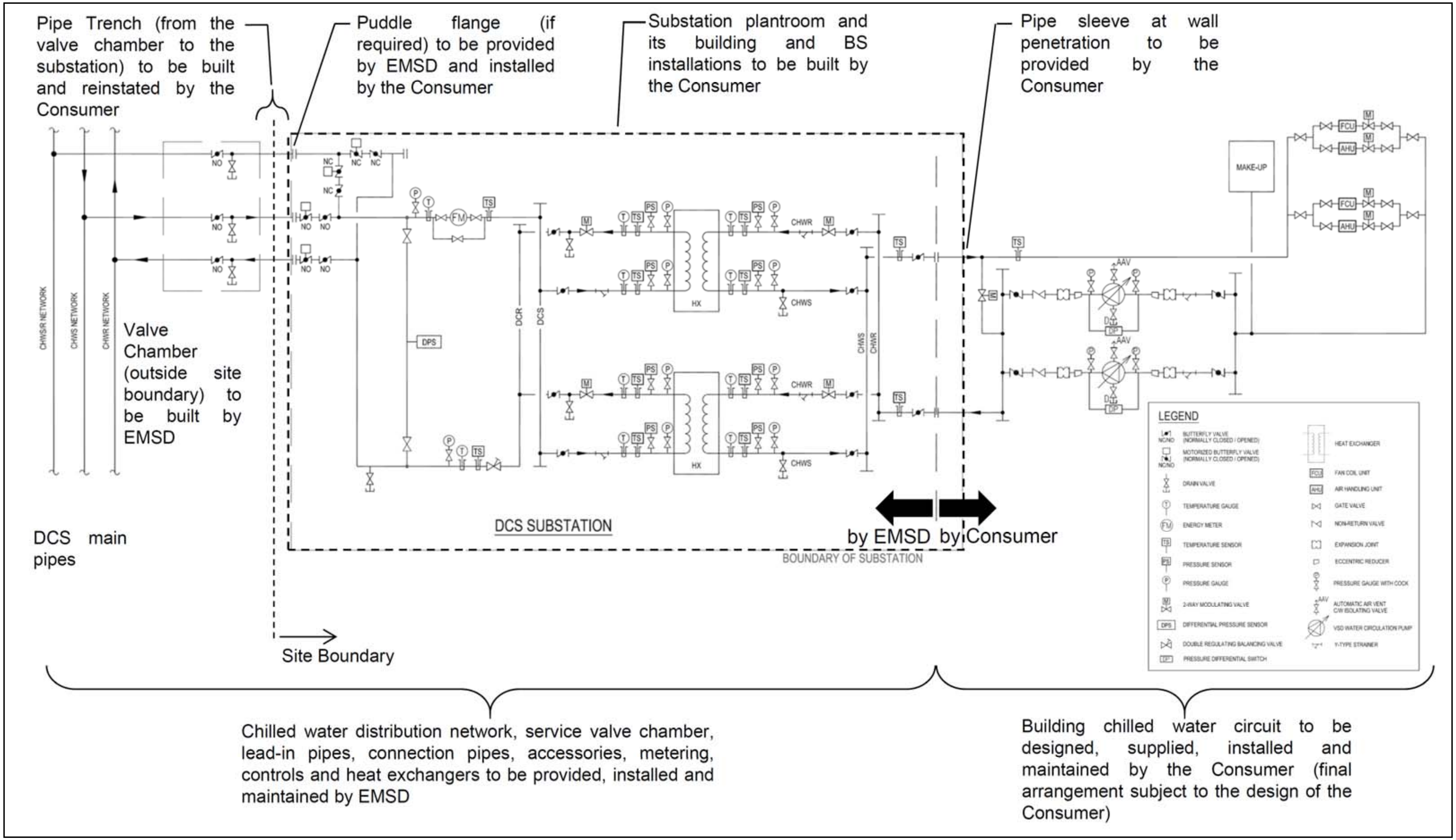


Fig. C1 – General Arragement on Constuction of Substation

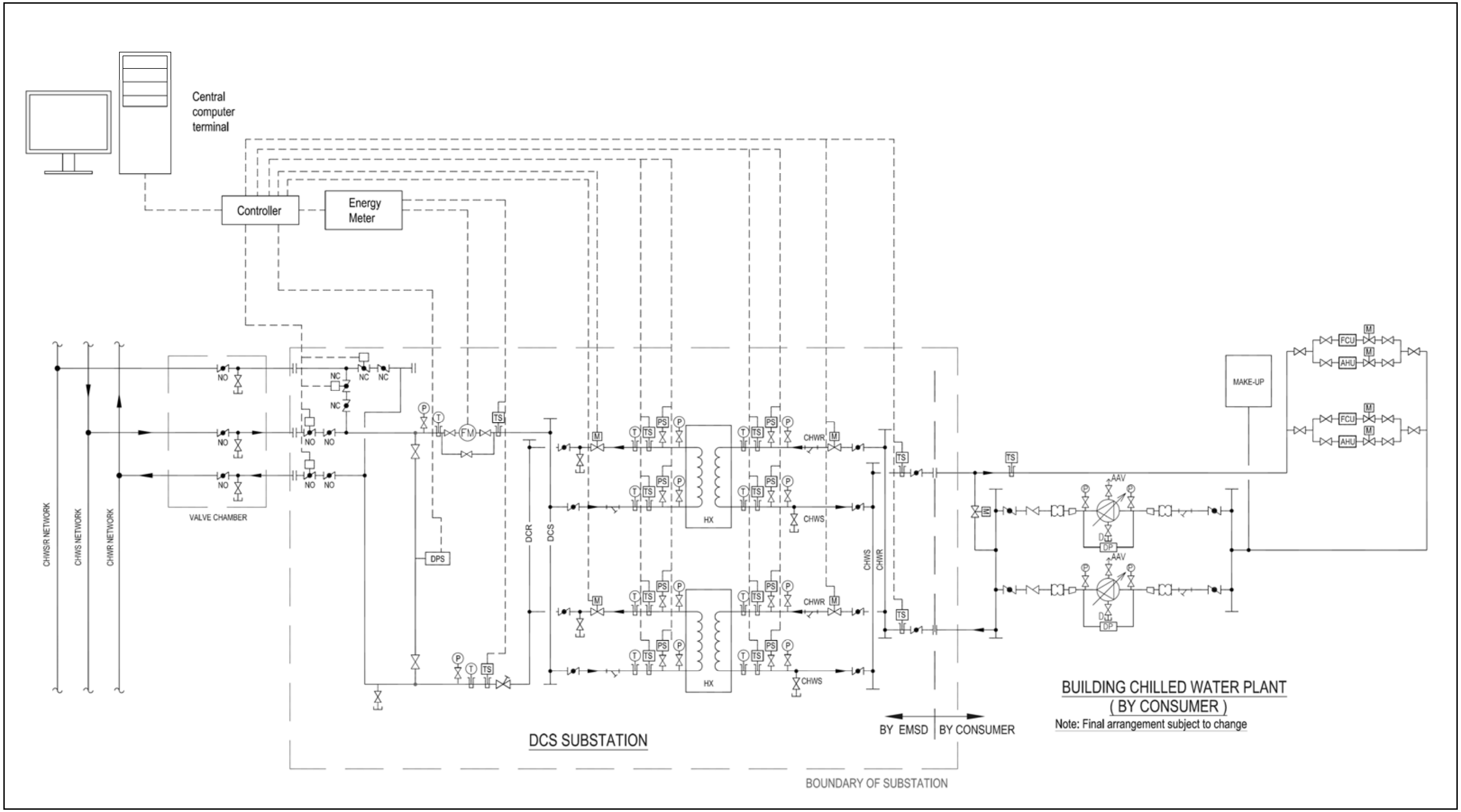
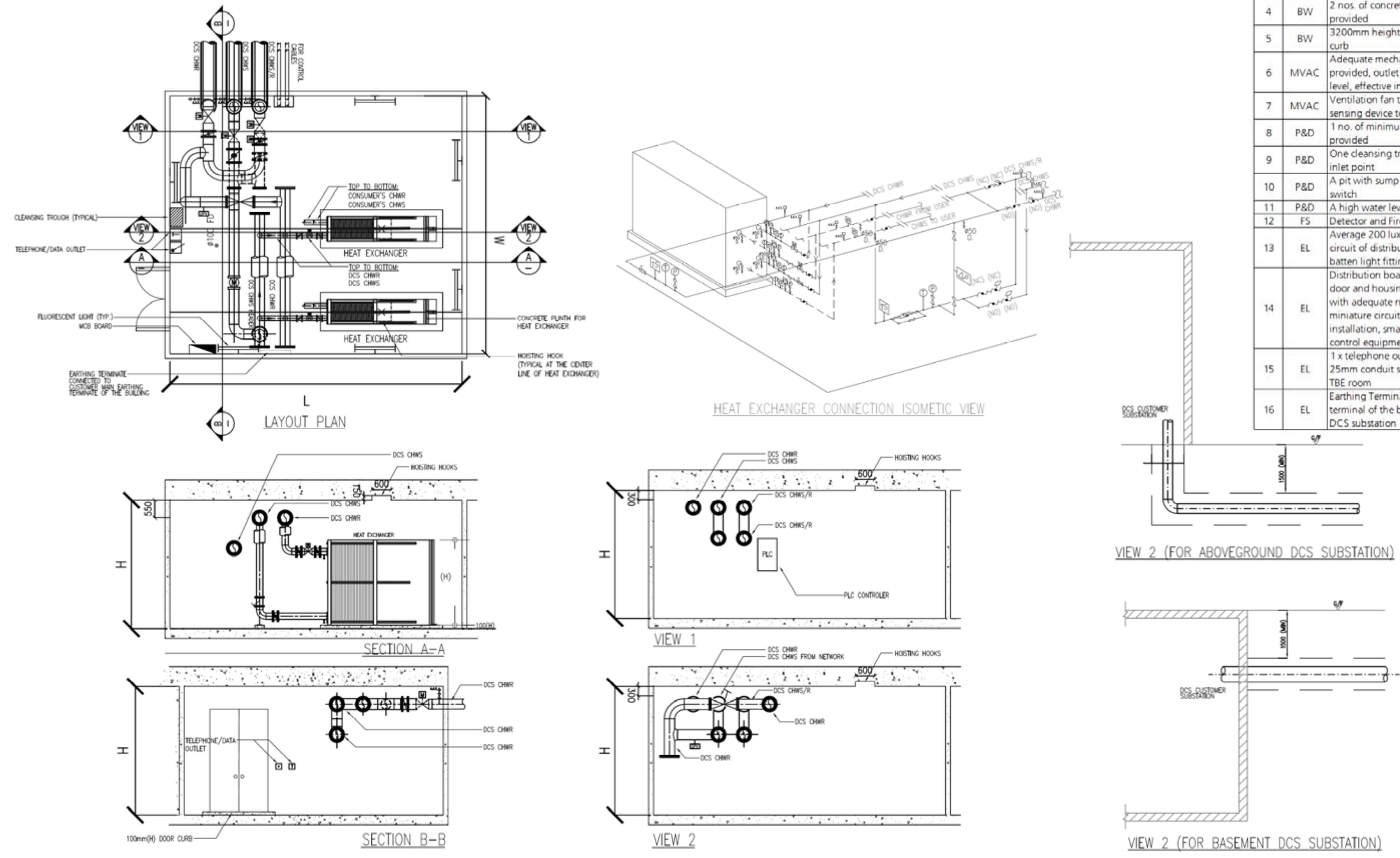


Fig. C2 – Control Schematic Diagram in Substation



Item	Trade	Building Services and Builders Works Provisions in DCS Substation by the Consumer
1	BW	3m x 4.5m delivery access is required from outside to DCS substation
2	BW	Permanent hoisting hook by the consumer shall be provided on above each of the heat exchanger
3	BW	Ground level substation shall be at least 150mm high than outside
4	BW	2 nos. of concrete plinth for heat exchangers to be provided
5	BW	3200mm height door shall be provided with 100mm curb
6	MVAC	Adequate mechanical ventilation system to be provided, outlet shall be minimum 2.5m above street level, effective inlet louvre c/w filter shall be provided
7	MVAC	Ventilation fan to be controlled by a temperature sensing device to avoid unnecessary operation
8	P&D	1 no. of minimum dia. 100mm floor drain shall be provided
9	P&D	One cleansing trough with faucet of 32mm water inlet point
10	P&D	A pit with sump pump with automatic and manual switch
11	P&D	A high water level sensor and alarm
12	FS	Detector and Fire Extinguisher shall be provided
13	EL	Average 200 lux measured on the floor level, different circuit of distribution board with twin fluorescent batten light fitting for 1.2m T5 fluorescent tube
14	EL	Distribution board shall be located near main access door and housing a 32A 4 pole main switch together with adequate number of final circuit protected by miniature circuit breaker (MCB) for lighting installation, small power, ventilation and metering control equipment
15	EL	1 x telephone outlet and 1 x data outlet complete dia. 25mm conduit shall be provided and connected to TBE room
16	EL	Earthing Terminal connecting to the main earthing terminal of the building shall be provided inside the DCS substation

Fig. C3 – Typical Layout of Substation of Two Heat Exchangers

Item	Trade	Building Services and Builders Works Provisions in DCS Substation by the Consumer
1	BW	3m x 4.5m delivery access is required from outside to DCS substation
2	BW	Permanent hoisting hook by the consumer shall be provided on above each of the heat exchanger
3	BW	Ground level substation shall be at least 150mm high than outside
4	BW	3 nos. of concrete plinth for heat exchangers to be provided
5	BW	3800mm height door shall be provided with 100mm curb
6	MVAC	Adequate mechanical ventilation system to be provided, outlet shall be minimum 2.5m above street level, effective inlet louvre c/w filter shall be provided
7	MVAC	Ventilation fan to be controlled by a temperature sensing device to avoid unnecessary operation
8	P&D	2 nos. of minimum dia. 100mm floor drain shall be provided
9	P&D	One cleansing trough with faucet of 32mm water inlet point
10	P&D	A pit with sump pump with automatic and manual switch
11	P&D	A high water level sensor and alarm
12	FS	Detector and Fire Extinguisher shall be provided
13	EL	Average 200 lux measured on the floor level, different circuit of distribution board with twin fluorescent batten light fitting for 1.2m T5 fluorescent tube
14	EL	Distribution board shall be located near main access door and housing a 32A 4 pole main switch together with adequate number of final circuit protected by miniature circuit breaker (MCB) for lighting installation, small power, ventilation and metering control equipment
15	EL	1 x telephone outlet and 1 x data outlet complete dia. 25mm conduit shall be provided and connected to TBE room
16	EL	Earthing Terminal connecting to the main earthing terminal of the building shall be provided inside the DCS substation

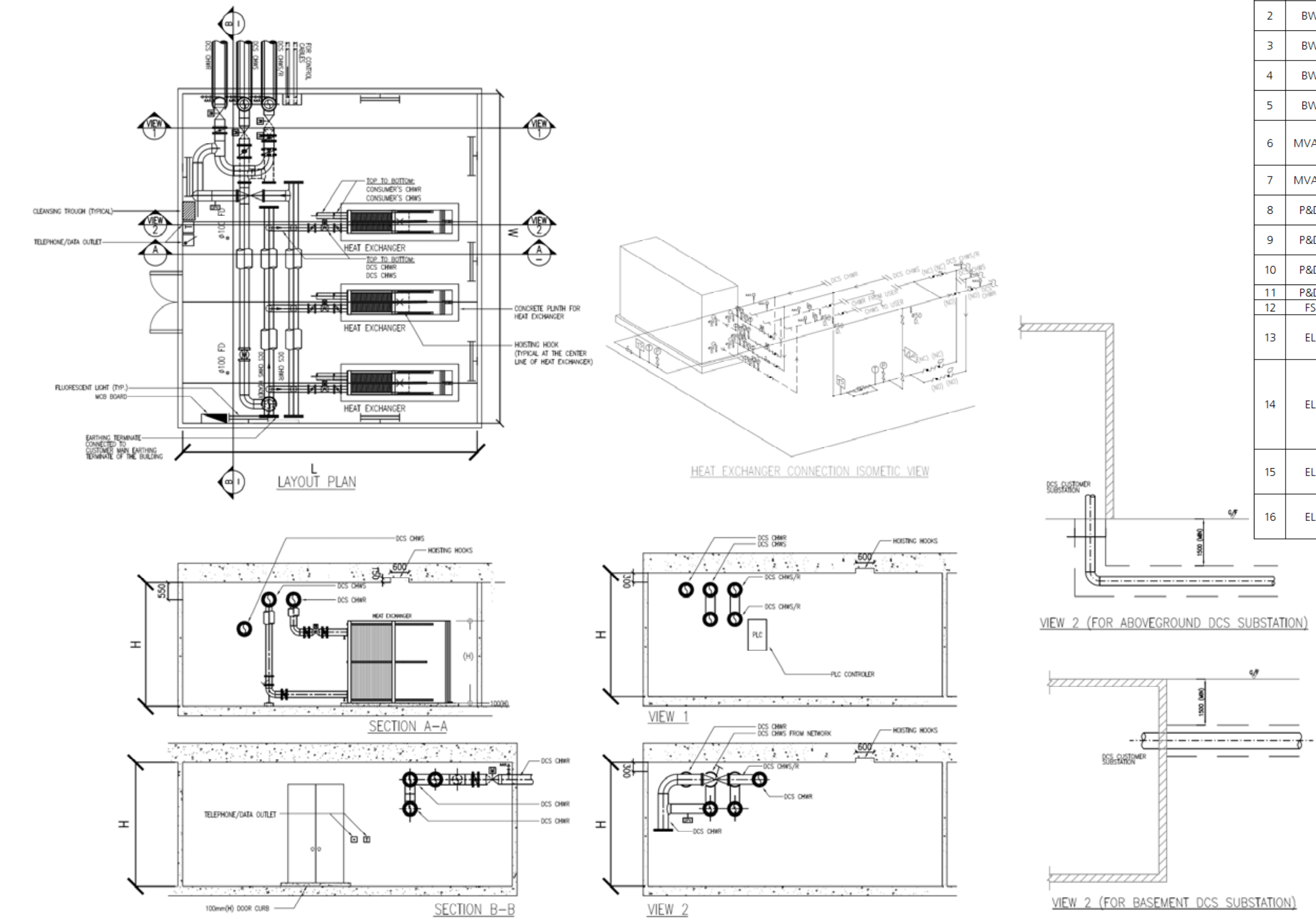


Fig. C4 – Typical Layout of Substation of Three Heat Exchangers

Appendix D

Substation Type	Cooling Capacity (kW)	Heat Exchanger (no x kW)	Operating Weight (each PHE)(kg)	PHE size (L x W x H)(mm)	Clear Room Size (L x W x H)(mm)	Floor Drain (no. & size)	FS Provision	Ventilation Flow Rate (ACH/hr)	Cleasing trough with fauet	Hoisting Hook (kg)	Lead-in service pipes	Trench Width (WxH)mm	Lighting (Lux)	Lighting Fixture IP
1	100	2x60	1000	800x400x1300	7000x4500x3500	1 x Φ100	Heat Detector & FE	6	1 x Φ32	1000	Φ80	2600x950	200	IP 54
2	200	2x120	1100	700x480x2400	7000x4500x3500	1 x Φ100	Heat Detector & FE	6	1 x Φ32	1500	Φ80	2600x950	200	IP 54
3	300	2x180	1250	1100x480x2400	7000x4500x3500	1 x Φ100	Heat Detector & FE	6	1 x Φ32	1500	Φ100	2800x950	200	IP 54
4	400	2x240	1350	1100x480x2400	7000x4500x3500	1 x Φ100	Heat Detector & FE	6	1 x Φ32	1500	Φ100	2800x950	200	IP 54
5	500	2x300	1450	1200x610x2400	7000x5000x4400	1 x Φ100	Heat Detector & FE	6	1 x Φ32	1500	Φ125	2900x950	200	IP 54
6	1000	2x600	2200	1410x610x2400	7000x5000x4400	1 x Φ100	Heat Detector & FE	6	1 x Φ32	2500	Φ150	3000x1050	200	IP 54
7	2500	2x1500	3750	2600x610x2400	8000x7000x4400	1 x Φ100	Heat Detector & FE	6	1 x Φ32	4000	Φ200	3200x1100	200	IP 54
8	5000	2x3000	7500	3300x770x2700	8500x8500x4700	1 x Φ100	Heat Detector & FE	6	1 x Φ32	8000	Φ300	3500x1200	200	IP 54
9	7500	2x4500	10250	5300x770x2700	10000x10000x4700	1 x Φ100	Heat Detector & FE	6	1 x Φ32	10500	Φ400	3800x1400	200	IP 54
10	10000	3x4000	9500	4800x770x2700	10000x12000x4700	2 x Φ100	Heat Detector & FE	6	1 x Φ32	10000	Φ400	3800x1400	200	IP 54
11	12500	3x5000	13400	5300x770x3300	10000x12500x5300	2 x Φ100	Heat Detector & FE	6	1 x Φ32	14000	Φ500	4200x1500	200	IP 54
12	15000	3x6000	16300	5300x970x3300	10000x13500x5300	2 x Φ100	Heat Detector & FE	6	1 x Φ32	17000	Φ500	4200x1500	200	IP 54
13	20000	3x8000	19900	6250x970x3300	11500x14500x5300	2 x Φ100	Heat Detector & FE	6	1 x Φ32	20000	Φ600	4500x1500	200	IP 54
14	24000	4x7200	19000	6000x970x3300	13000x16500x5300	2 x Φ100	Heat Detector & FE	6	1 x Φ32	19500	Φ700	4800x1600	200	IP 54

Table D1 – Building and Building Services Provisions of Substations for Different Cooling Capacities